

2.3.2 Ion evidence and titration concentration

Name: _____ Class: _____ Date: _____

Total: 19 marks

KEY WORDS standard solution

Objective

Use separate ion tests and a balanced mole ratio to determine an unknown concentration. All questions and marking guidance are original.

1 Key knowledge and worked examples

Use separate aliquots. Acidify a sulfate test with dilute HCl before BaCl₂; use dilute HNO₃ before AgNO₃ for halides. HCl would introduce chloride and spoil the latter test. Warm ammonium salts with aqueous NaOH; ammonia turns damp red litmus blue.

■ Worked method

25.00 cm³ of 0.0500 mol dm⁻³ Na₂CO₃ uses 24.60 cm³ HCl. Na₂CO₃ + 2HCl → 2NaCl + CO₂ + H₂O.

$$n(\text{Na}_2\text{CO}_3) = cV = 0.0500 \times 0.02500 = 0.001250 \text{ mol}$$

$$n(\text{HCl}) = 2n(\text{Na}_2\text{CO}_3) = 0.002500 \text{ mol}$$

$$c(\text{HCl}) = n/V = 0.002500/0.02460 = 0.1016 \text{ mol dm}^{-3}$$

Concordant titres agree within the method's specified tolerance. Do not include the rough titre in their mean. A titre uses two readings, so add their absolute uncertainties.

2 Practice

2.1 Write the ionic equation for sulfate detection and explain acidification before adding BaCl_2 . [3]

2.2 AgNO_3 gives a cream precipitate after acidification with HNO_3 . State the likely halide and its behaviour with dilute and concentrated ammonia. [3]

2.3 A burette reads 0.25 cm^3 initially and 23.90 cm^3 finally. Calculate the titre and its maximum percentage uncertainty if each reading is $\pm 0.05 \text{ cm}^3$. [3]

3 Exam-style questions

3.1 25.00 cm^3 of H_2SO_4 is neutralised by 20.40 cm^3 of $0.1000 \text{ mol dm}^{-3}$ NaOH . Calculate acid concentration in mol dm^{-3} and g dm^{-3} . $M(\text{H}_2\text{SO}_4) = 98.0 \text{ g mol}^{-1}$. [5]

3.2 Describe four actions needed to make an accurately known standard solution from a weighed solid acid. Explain why extra deionised water in a titration flask does not change the acid amount delivered by a pipette. [5]

Solutions

Original marking guidance: M1 method, A1 accuracy, B1 explanation.

2.1 $\text{Ba}^{2+} + \text{SO}_4^{2-} \rightarrow \text{BaSO}_4(\text{s})$. Acid removes carbonate interference.

2.2 Bromide; AgBr remains in dilute ammonia but dissolves in concentrated ammonia.

2.3 Titre = $23.90 - 0.25 = 23.65 \text{ cm}^3$. Uncertainty $\pm 0.10 \text{ cm}^3$; $100(0.10/23.65) = 0.42\%$.

3.1 $\text{H}_2\text{SO}_4 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$. $n(\text{NaOH}) = cV = 0.1000 \times 0.02040 = 0.002040 \text{ mol}$; $n(\text{acid}) = 0.001020 \text{ mol}$. $c = n/V = 0.001020/0.02500 = 0.04080 \text{ mol dm}^{-3}$; mass concentration = $cM = 0.04080 \times 98.0 = 4.00 \text{ g dm}^{-3}$.

3.2 Accurately weigh solid; dissolve fully; transfer quantitatively with rinsings; make to the volumetric mark at eye level then mix thoroughly. Extra flask water changes concentration but not the moles already pipetted.